Future Experiments

- G. Feldman: Progress report from NUMI off-axis
- R. Bernstein: Independent study of NUMI off-axis sensitivity
- K. Kodama: Progress report on CNGS and Opera/Icarus
- Y. Obayashi: JHF progress report and $\theta_{13}$ sensitivity
- J. Burguet-Castell: JHF intermediate detector
- S. Kahn: BNL/Homestake proposal
- G. Rajasekaran: A large iron detector for the neutrino factory
- Y. Efremenko: A long-baseline experiment in the IHEP tunnel
Future Experiments

- LBL; approved, ongoing
  - K. Kodama  Progress report on CNGS and Opera/Icarus

- LBL; proposed, realistically studied
  - Y. Obayashi  JHF progress report and $\theta_{13}$ sensitivity
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- VLBL; conventional beam
  - S. Kahn  BNL/Homestake proposal
  - Y. Efremenko  A long-baseline experiment in the IHEP tunnel

- VLBL; neutrino factory
  - G. Rajasekaran  A large iron detector for the neutrino factory
CNGS, OPERA and ICARUS status

long baseline $\nu_t$ appearance experiments

• CNGS: First beam to Gran Sasso: May, 2006
• OPERA
  ✓ Emulsion delivery to Gran Sasso starts in August 2003
  ✓ Run from Day 1
  ✓ Emulsion analysis for event location must be ready before Day 1
  ✓ Rehearsal for event location using “mini-OPERA” at KEK-PS in 2004

• ICARUS (A. Rubbia, plenary talk)
  ✓ T600 installation at CNGS has been approved in March 2003.
  ✓ T3000 = T600 + T1200 + T1200
JHF-Kamioka Neutrino Experiment

Y. Obayashi

Plan to start in 2007

Super-K: 22.5 kt
Hyper-K: 1000 kt

~1GeV ν beam

J-PARC (Tokai)

0.75MW 50 GeV PS
4 MW 50 GeV PS

( conventional ν beam)

WG1 Summary
NuFact03, June 11, 2003
Neutrino Beamline

- Off-axis
- Design in progress.
- Budget request submitted.
- Will be ready to start construction in 2004.
Detectors

- Muon monitors @ ~140m
  - Fast (spill-by-spill) monitoring of beam direction/intensity
- First Near detector @ 280m
  - Neutrino intensity/spectrum/direction
- Second Near Detector @ ~2km
  - Almost same $E_\nu$ spectrum as for SK
  - Water Cherenkov can work
- Realistic sensitivity studies and detector design studies started.

Role of the 2 km intermediate detector studied by Burguet-Castell: It will drastically simplify the systematic error analysis.
There are some other longer baseline sites up to ~950 km.
Active elements: scintillators or RPCs considered
Absorber: consensus to use particle board
NuMI off-axis

- LOI submitted August 2002 (P929)
- Intention to submit proposal to November 2003 PAC
- 50 kton, 5 yr, $4 \times 10^{20}$ pot/hr

Timetable: Possible Longer Term Schedule

- June 2004: PAC approval for a near detector
- 2004-2006 Near detector construction and running and far detector engineering
- 2006 Start of far detector construction
- 2009 Start of full run
- Note: The beam will exist and the detector is modular. The experiment can start prior to full completion.
R. Bernstein

- Simulation studies of NuMI off-axis
  - For $\nu_e$ appearance, simulated LAr and Fe/Scint, 100 kt/yr.
  - Can see effects down to $\sin^2 2\theta = 0.01$.
  - LAr much better
BNL → Homestake Super Neutrino Beam

S. Kahn

28 GeV protons, 1 MW beam power
500 kT Water Cherenkov detector
$5 \times 10^7$ sec of running, Conventional Horn based beam
\( \nu_e \) Appearance Measurements

- A direct measurement of the appearance of \( \nu_\mu \rightarrow \nu_e \) is important; the VLB method competes well with any proposed super beam concept.

- For values > 0.01, a measurement of \( \sin^2 2\theta_{13} \) can be made (the current experimental limit is 0.12).

- For most of the possible range of \( \sin^2 2\theta_{13} \), a good measurement of \( \theta_{13} \) and the CP-violation parameter \( \delta_{CP} \) can be made by the VLB experimental method.

DISCUSSION

- 1-ring QE event selection above a few GeV suffers from more BG.

- More realistic BG estimation suggested.
Y. Efremenko

**Concept**

Measurement of $\nu_\mu$ disappearance with a very large baseline

Fermilab ~7600 km
JHF ~7000 km
GSI ~2000 km

- **UNK tunnel** - huge scintillator based muon counter (not calorimeter !)
- Surrounding soil is a neutrino target ~1 Mton
- TOF and segmentation gives direction to the neutrino source
- Location at 50 m underground gives good cosmic ray background suppression
- Energy scan with Narrow Band neutrino beam to see oscillation pattern

UNK tunnel
(Left from terminated accelerator project at the IHEP, Protvino, Russia)
For $\Delta m_{\text{atm}}^2$ in the range of
$1.5 \times 10^{-3} \text{ ev}^2 < \Delta m^2 < 4.0 \times 10^{-3} \text{ ev}^2$

Expected accuracy in parameters measurements

For GSI: $\sigma_{\Delta m^2} = 2.7 \times 10^{-5} \text{ ev}^2$, $\sigma_{\sin^2 2\theta} = 0.01$
For JHF: $\sigma_{\Delta m^2} = 1.5 \times 10^{-5} \text{ ev}^2$, $\sigma_{\sin^2 2\theta} = 0.01$

This is ~1% error !!!

If we can do the same for antineutrinos say
with 2% accuracy, then:

Test of CTP on the 3% level
by compare $\Delta m^2$ for neutrinos with $\Delta m^2$ for antineutrinos

Sensitivity to matter effects on the 3% level

For $\Delta \mu = P(\nu_\mu) - P(\text{anti-}\nu_\mu)$
A large iron detector in India as a far end detector for a neutrino factory

India-based (or) Indian Neutrino Observatory (INO) and its role in long-base-line experiments

(Talk at NuFact 03, New York, June 2003)

G. Rajasekaran
Institute of Mathematical Sciences,
Chennai (Madras)
India

Detector: 30 kt magnetized iron calorimeter

Phase 1: atmospheric neutrino measurements

Phase 2: far detector for a neutrino factory experiment
## (“super-beam”) LBL experiments

<table>
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<tr>
<th></th>
<th>$E_p$ (GeV)</th>
<th>Power (MW)</th>
<th>Beam</th>
<th>$\langle E_\nu \rangle$ (GeV)</th>
<th>$L$ (km)</th>
<th>$M_{\text{det}}$ (kt)</th>
<th>$\nu_\mu \text{CC}$ (/yr)</th>
<th>$\nu_e$ @peak</th>
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<tr>
<td>K2K</td>
<td>12</td>
<td>0.005</td>
<td>WB</td>
<td>1.3</td>
<td>250</td>
<td>22.5</td>
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<td>MINOS(LE)</td>
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<td>0.41</td>
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<td>5.4</td>
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<td>WB</td>
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<td>OA</td>
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<td>295</td>
<td>22.5</td>
<td>~3,000</td>
<td>0.2%</td>
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<td>4</td>
<td>OA</td>
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<td>1,000</td>
<td>~600,000</td>
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<td>OA-NuMI</td>
<td>120</td>
<td>0.4</td>
<td>OA</td>
<td>~2</td>
<td>730?</td>
<td>50kt?</td>
<td>~2,500?</td>
<td>0.5%</td>
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<td>OA</td>
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<td>20kt?</td>
<td>~4,000?</td>
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<td>AGS→??</td>
<td>28</td>
<td>1.3</td>
<td>WB/OA</td>
<td>~1</td>
<td>2,500?</td>
<td>1,000?</td>
<td>~1,000?</td>
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<td>SPL-Furejus</td>
<td>2.2</td>
<td>4</td>
<td>WB</td>
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<td>130</td>
<td>40(400)</td>
<td>650(0)</td>
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<tr>
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<td>400</td>
<td>0.3</td>
<td>OA</td>
<td>0.8</td>
<td>~1200</td>
<td>1,000?</td>
<td>~400</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

T. Kobayashi, NuFact 02 (with modification for OA-NuMI)

WG1 Summary
NuFact03, June 11, 2003
Future Experiments: Summary

- CNGS: First beam May 2006
- OPERA: Preparing for Day 1
- ICARUS: T600 installation in Gran Sasso 2003 - 2004
- JHF: Ready to start construction in 2004
- NuMI off-axis: Detector choice advanced, Proposal November 2003
- BNL/Homestake: Realistic BG estimate suggested
- IHEP, INO detectors: New comers welcome, Realistic sensitivity studies encouraged